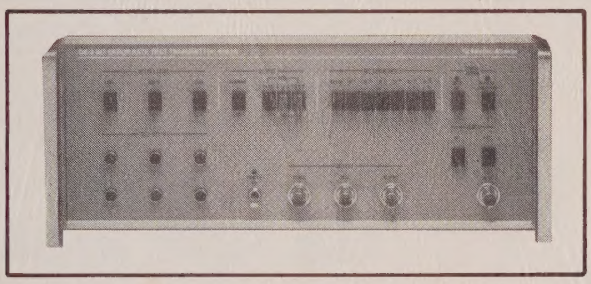
Instruction Manual

Model 4651A
Bit Error Rate Test Set
Transmitter
Operator's Manual



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MODEL NO. _____

SERIAL NO. _____

MODEL 4651A
BIT ERROR RATE TEST SET
TRANSMITTER
OPERATOR'S MANUAL

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First Edition

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TABLE OF CONTENTS

Section		Page
	CHAPTER 1 GENERAL INFORMATION	
1.1	General	1-1
1.2	Purpose of Equipment	1-1
1.3	General Description	1-2
	A. Model 4651A BERTS Transmitter	1-2
	B. Model 4652A BERTS Receiver	1-3
1.4	Technical Characteristics	1-3
	CHAPTER 2 INSTALLATION	
2.1	General	2-1
2.2	Unpacking and Inspection	2-1
2.3	Accessories Supplied	2-2
2.4	Installation	2-2
	A. Power Sources	2-2
	B. Typical Test Configuration	2-3
	CHAPTER 3 OPERATION	
3.1	General	3-1
3.2	Front Panel Controls and Indicators	3-2
3.3	Rear Panel Connectors	3-5
3.4	Operation	3-5
	A. Output Level Select	3-6
	B. Output Signal Select	3-6
	C. Error Rate Select	3-7
	D. Single Error Insert	3-8
	E. Output Connectors	3-8
	F. Clock Select	3-8
	G. NRZ Data Format	3-9

LIST OF ILLUSTRATIONS

Figure	Title	Page
2.1	Selecting the Proper Operating Voltage	2-4
2.2	System Loop-Back Test Using BERTS Equipment, Block Diagram	2-5
2.3	System End-to-End Test Using BERTS Equipment, Block Diagram	2-6
2.4	Typical Connections for BERTS Equipment When Making Threshold Test, Block Diagram	2-7
2.5	Typical Connections for BERTS Equipment When Testing Digital Modems, Block Diagram	2-7
2.6	Typical Connections for BERTS Equipment When Testing Digital Modems with Added White Noise, Block Diagram	2-8
2.7	Typical Connections Using BERTS Equipment Testing Lightwave Transmission Equipment Operation at T-3 Rate	2-10
3.1	Model 4651A BERTS Transmitter, Front Panel Controls and Indicators	3-2
3.2	Model 4651A, Rear Panel Features	3-5
3.3	NRZ Data Format Select	3-10

LIST OF TABLES

Table	Title	Page
3.1	Model 4651A BERTS Transmitter, Identification of Controls and Indicators	3-2

CHAPTER 1
GENERAL INFORMATION

1.1 GENERAL

This instruction manual contains information for the installation and operation of the Scientific-Atlanta Model 4651A Bit Error Rate Test Set (BERTS) Transmitter. The theory of operation, maintenance, parts listing, and applicable drawings are contained in a separate instruction manual identified for MAINTENANCE. Both the Instruction and the Maintenance Manual for the 4651A appear similar to those supplied with the Model 4651 Bit Error Rate Test Set Transmitter. However, there are significant differences between the two versions. For this reason, be sure that the correct manuals have been supplied with your unit.

It is recommended that before operation, or attempting an adjustment for repair, that the appropriate sections in these manuals be read carefully. Factory or customer specified modifications, when applicable, and/or general instruction manual updating will be described in a Notice Sheet and will be contained in the rear cover envelope of the appropriate Instruction Manual.

1.2 PURPOSE OF EQUIPMENT

The complete Bit Error Rate Test Set package consists of two units: (1) the Model 4651A BERTS Transmitter, and (2) the Model 4652A BERTS Receiver. These units are designed to aid testing digital-to-digital measurements on digital transmission equipment such as DS3 (44.736 Mbit/sec) digital data links. The Model 4651A BERTS Transmitter generates test signals and the Model 4652A BERTS Receiver performs a variety of error measurements on the received data. Normally, the Model 4651A BERTS Transmitter would be connected into a DS3 transmitter which transmits digital data over various media (microwave,

optical, cable) while the DS3 receiver output would be input into the Model 4652A BERTS Receiver for error measurements.

The Model 4651A Transmitter, along with its counterpart the Model 4652A Receiver, provides total measurement capability for field use, commissioning, or for laboratory tests.

1.3 GENERAL DESCRIPTION

Six independent transmitter output signals are available through the front panel DS3 OUTPUT connectors and are B3ZS encoded bipolar format. Separate BNC-type OUTPUT connectors on the front panel provide a buffered transmitter output signal for CLOCK and DATA in NRZ unipolar format. The output signals can be selected as "ALL ONES", "ALL ONES DATA" or "ALL ZEROS DATA", or as "PSEUDO RANDOM DATA" (a 32767 bit code). Output signals can also be selected as alternate 1-0 format simulating the BLUE signal or idle channel indicator. In all data modes, framing bits can be enabled or disabled.

Six error rates for bit and parity errors can be switch selected between 10^{-3} and 10^{-8} using front panel pushbutton switches. Front panel switches are also provided to insert individual bit/parity errors (SINGLE ERROR - BIT) or bipolar violations (SINGLE ERROR - BIPOLAR VIOLATION). An input for External Clock is available on the front panel which can be used for jitter testing when desired.

1.4 TECHNICAL CHARACTERISTICS

A summary of technical characteristics for the Model 4651A Bit Error Rate Transmitter components is provided in the following specifications:

Model 4651A BERTS Transmitter

Internal Clock	
Frequency:	44.736 MHz (DS3) crystal source
Stability:	±20 ppm, 0 to 20 years, 0° to 50°C
External Clock	
Input Connector:	BNC type
Impedance:	75 ohms, ac coupled
Frequency:	10 MHz to 45 MHz
Amplitude:	1.0 volt peak-to-peak
Interface:	ECL compatible
OUTPUT - CLOCK	
Connector:	BNC type
Impedance:	75 ohms, ac coupled
Amplitude:	1.0 volt peak-to-peak
Frequency:	CLOCK-INT Switch depressed = 44.736 MHz CLOCK-EXT Switch depressed = External Clock frequency Both INT and EXT Switches released = No output clock
OUTPUT - DATA	
Connector:	BNC type
Impedance:	75 ohms
Amplitude:	Internally selectable to TTL, ECL, or 1.0 volt peak-to-peak (bipolar)
Frequency:	INT or EXT clock, switch selectable
OUTPUT - UNIPOLAR DATA	
Framing:	DS3 frame structure may be superimposed on the selected data pattern or disabled
Format:	Unipolar, non-return to zero (NRZ)

Model 4651A BERTS Transmitter - continued

Interface:	TTL compatible; will drive 50 or 75 ohm termination with one pulse per superframe
OUTPUT - M-SYNC	
Format:	Unipolar signal
Interface:	TTL compatible; will drive 50 or 75 ohm termination
OUTPUT - B3ZS	
Connector:	Six (6) independent WECo 440 type
Impedance:	75 ohms
Framing:	DS3 frame structure (when enabled) superimposed on selected data pattern
Format:	Coded in B3ZS (bipolar) format, with choice of 3 output waveforms: HIGH = 1.82(±0.5) volt peak-to-peak LOW = 0.37(±0.1) volt peak-to-peak DSX-3 = processed vesion of HIGH waveform, simulating the HIGH output through 450 feet of type 728A cable
Pulse Characteristics	
Width:	11.2(±1.1) nS (at half amplitude)
Rise/fall:	4.5(±1.5) nS
Over/undershoot:	Less than 10% of pulse amplitude
Data Patterns*	
PRBS:	Pseudo-random bit sequence of 32767 bits
1111:	Continuous ...111...
0000:	Continuous ...000...
BLUE:	Continuous ...10101... selected by pressing both the 1111 and 0000 button

*Note that all four data patterns are available with or without the DS3 framing structure. Framing is selected when the FRAMING button is in and is de-selected when it is out.

Model 4651A BERTS Transmitter - continued

Error Insertion:	Single Errors: by pressing the single error button, single bit (and parity if framing is selected) or bipolar violation errors may be inserted into the output data Constant Errors: bit (and parity if framing is selected) errors at a fixed bit error rate can be inserted by pressing one of the Bit Error Rate buttons. Rates of 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, and 10^{-8} are available.
GENERAL FEATURES	
Power Supply:	Operates from either line voltage of 115/220V ac (±10%), 50 to 60 Hz, or station battery of -22V to -60V dc with positive ground.
Power Dissipation:	50 Watts
Weight:	7.7 kilograms (17 pounds)
Dimensions:	33 cm W x 38.1 cm D x 13.3 cm H (13 in. W x 15 in. D x 5.25 in. H)
Temperature:	Operating: 0° to +50°C Storage: -20° to +50°C

CHAPTER 2
INSTALLATION

2.1 GENERAL

This chapter contains information necessary to properly connect the Model 4651A Transmitter into a digital communications system and prepare it for initial operation. Operating instructions are provided in Chapter 3 - OPERATION.

2.2 UNPACKING AND INSPECTION

Carefully unpack the shipping cartons observing all printed instructions. Separate the packing material from the main units and any packages of loose items (i.e., hardware, cables, connectors, etc.). Temporarily set the shipping cartons and packing material aside in a safe place and inspect the units and associated items, if any, for shipping damage. If damage is evident, contact both the carrier and the nearest Scientific-Atlanta sales representative immediately. Save the packing materials and shipping papers for inspection by the carrier's representative. Do not return a unit to Scientific-Atlanta without receiving specific return shipment instructions.

Save the shipping cartons and packing material even after satisfactory operation of the Model 4651A is determined. They may then be useful for storage, or for protection during further transport of the equipment.

An inventory checklist is provided in Section 2.3 for accessories that have been supplied with your unit. Should an item be missing (or damaged) from the accessory kit, contact your nearest Scientific-Atlanta representative for assistance.

2.3 ACCESSORIES SUPPLIED

The Model 4651A BERTS Transmitter comes complete with the following Accessory Kit (Part No. 256267):

___ Operator's Manual (Part No. 254776)
___ Maintenance Manual (Part No. 254777)
___ Power Cord (Part No. 89672)
___ Fuses:
___ 1 Amp Slo Blo (Part No. 71220)
___ 5 Amp Slo Blo (Part No. 71232)
___ 10 Amp Slo Blo (Part No. 71236)
___ Connector, Rect. Plug Housing (Part No. 89689)
___ Connector, Contact Pin (Part No. 87460)

2.3 INSTALLATION

A. POWER SOURCES

The Model 4651A BERTS Transmitter can be operated from either a 115/220V ac 50-60 Hz source or a positive ground battery source providing from -22V to -60V dc.

CAUTION

BE SURE THE FRONT PANEL POWER SWITCH IS IN THE OFF (DOWN) POSITION BEFORE CONNECTING BATTERY SOURCE VOLTAGE. ALTHOUGH THE CIRCUITS ARE VOLTAGE PROTECTED, IT IS POSSIBLE TO BLOW A PROTECTING FUSE WHICH IS MOUNTED INTERNALLY AND REQUIRES PARTIAL DISASSEMBLY TO PERMIT REPLACEMENT.

If there is any question about the power source, it is best to check it with a meter to verify that the voltage is within operating range required by the equipment. It is permissible to connect the equipment to both ac and dc power sources simultaneously. The power supply circuit rectifies and filters the stepped down ac voltage which is directed through a diode OR circuit with the applied dc source voltage. Whichever voltage is greater will be the power source for the equipment.

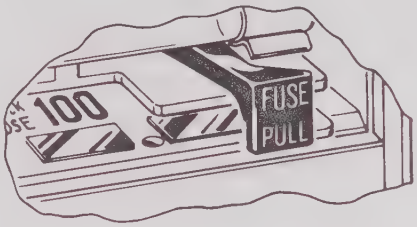
The rectified ac source potential is approximately 42V dc. If the dc source potential is less than 42V dc, the ac source will power the equipment. Likewise, if the dc potential is greater than 42V dc, the dc source will power the equipment. This arrangement permits highly reliable, uninterrupted service modes. Remember that the equipment will operate from the higher source potential.

There may be times when a fuse fails and requires replacement. For ac fuse requirements, refer to Figure 2.1 for further instructions. Use only the proper fuse size and rating indicated on the rear panel. DC voltage input fuses are located on a printed circuit board mounted to the inside of the rear panel. Access to these fuses is possible after removing the equipment top and bottom covers.

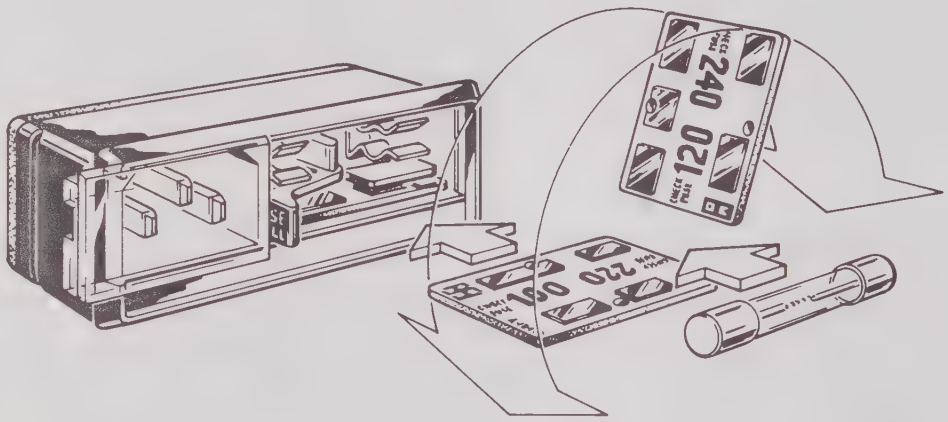
B. TYPICAL TEST CONFIGURATION

1. Loop-Back Test

Both the Transmitter and Receiver of a BERTS arrangement are required to perform a Loop-Back Test on a digital radio system, a fiber optics system, or on digital modems. The basic requirements are the same and are illustrated by the block diagram in Figure 2.2. The System Under Test transmitter output is conveniently patched to the system receiver. Using similar patching techniques, output signals from a Model 4651A BERTS Transmitter are fed into the system transmitter and a Model 4652A BERTS Receiver is connected into the system receiver output. Test results can verify bit error rate, bipolar coding errors, parity errors, etc.



Operating voltage is shown through the sliding plastic window.



HOW TO SELECT OPERATING VOLTAGE

1. Remove the ac power cord connector.
2. Slide the plastic window to the left.
3. Carefully operate FUSE PULL tab to the left.
4. Carefully remove both the fuse and printed circuit board. A small hole is provided to accommodate a wire pull if necessary.
5. Correctly orient the printed circuit board so the desired voltage is located on the top left side.
6. Carefully return to printed circuit board to the original location. Be sure it is securely seated.
7. Return FUSE PULL tab to the normal position.
8. Replace the original fuse with one selected for correct fuse value.

Illustrations courtesy of Corcom Corp., Chicago, Ill.

Figure 2.1. Selecting the Proper Operating Voltage

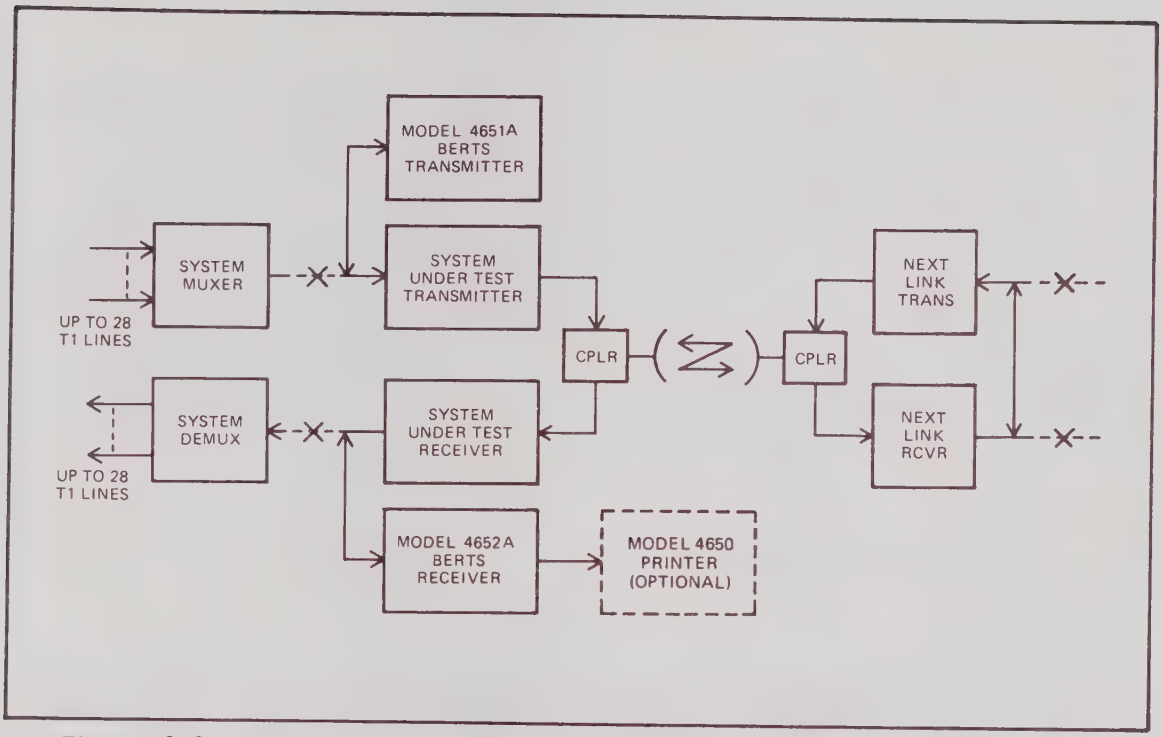


Figure 2.2. System Loop-Back Test Using BERTS Equipment, Block Diagram

2. End-to-End Test

Two individual Models 4651A/4652A BERTS arrangements are required to perform simultaneous End-to-End Tests in both directions. A typical set-up is illustrated by the block diagram in Figure 2.3. Patching the respective Model 4651A BERTS Transmitter and Model 4652A BERTS Receiver into the system signal paths, each Model 4652A BERTS Receiver will test evaluate the transmission of the opposite end Model 4651A BERTS Transmitter. Common tests include bit error rate, bipolar coding errors, parity errors, etc.

3. Testing Simulated Fade Conditions

Using the Model 4651A BERTS Transmitter(along with a 4652A Receiver) with a carrier/noise simulator such as a Scientific-Atlanta Model 4647 IF Noise Test Set (or equivalent), an operator can add noise to the system 70 MHz IF and perform carrier-to-noise versus Error Rate Measurements. This test

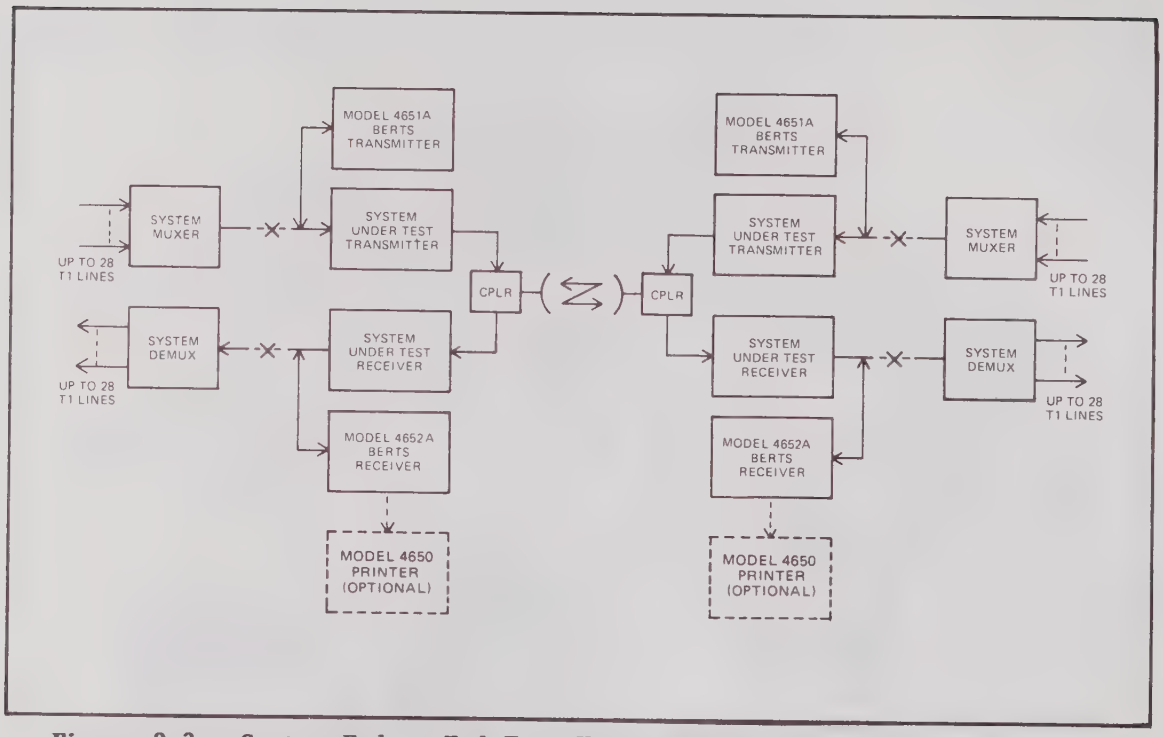


Figure 2.3. System End-to-End Test Using BERTS Equipment, Block Diagram

signal, together with a normal incoming digital signal, simulates noise due to fading. A typical equipment arrangement is shown by the block diagram in Figure 2.4. This method permits Bit Error Rate measurements to be done during production testing of a digital terminal or in the field (commissioning and maintenance) without the scintillation effects of normal RF receive signals.

4. Digital Modem Testing

The BERTS equipment can be used for either production or field testing on digital subsystems which include the modulator/encoder/scrambler. A typical connection arrangement is shown in the block diagram of Figure 2.5. It should be noted that both bit-error-rate (BER) measurements and clock jitter can be determined using this arrangement of interconnection.

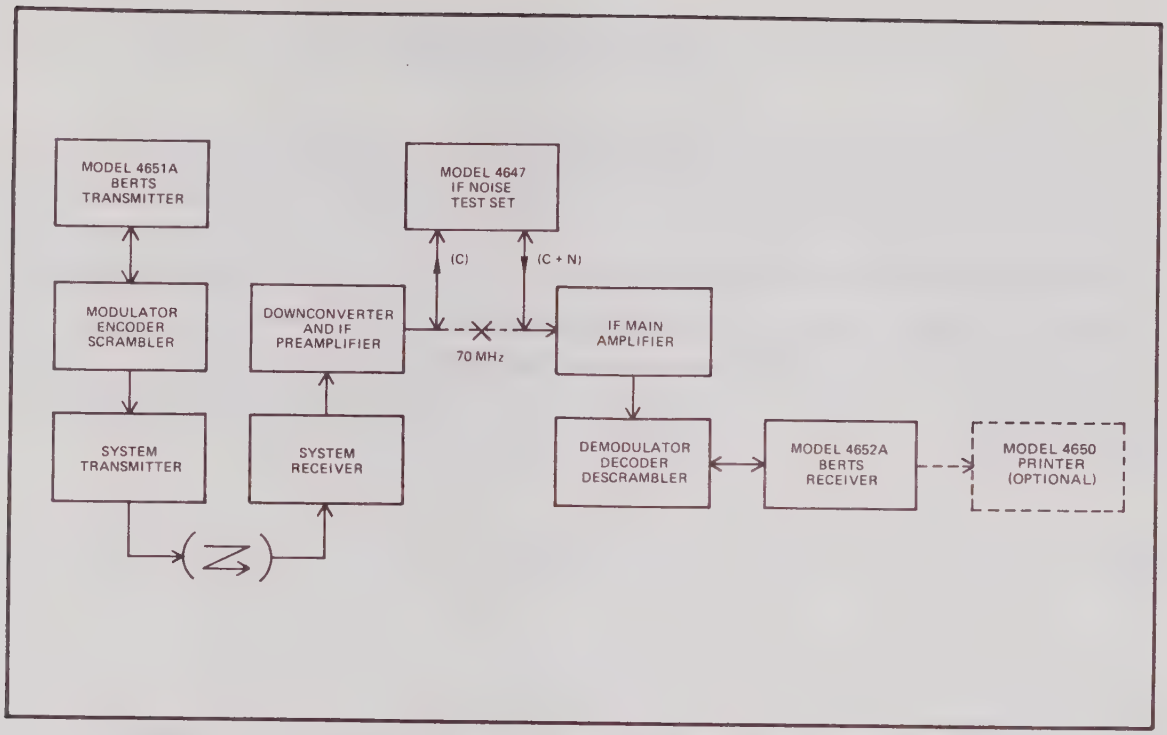


Figure 2.4. Typical Connections for BERTS Equipment When Making Threshold Test, Block Diagram

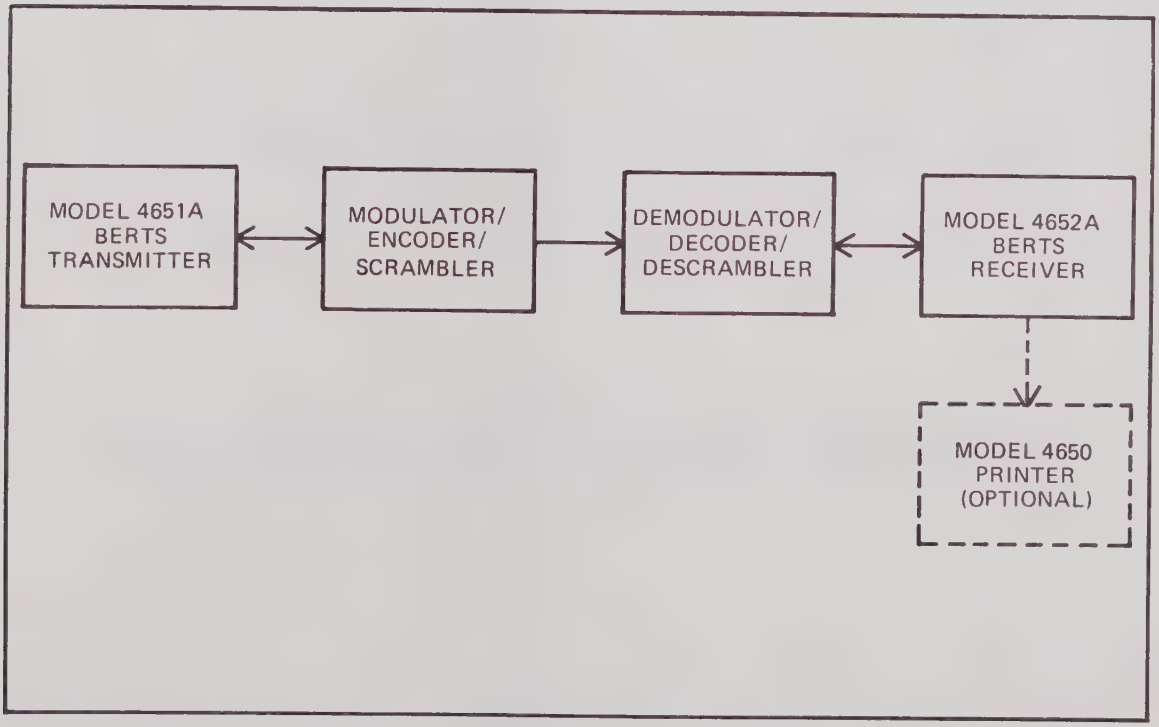


Figure 2.5. Typical Connections for BERTS Equipment When Testing Digital Modems, Block Diagram

5. Digital Modem Testing With Added Noise

The BERTS equipment can be used with a white noise generator, such as the Scientific-Atlanta Model 4647 IF Noise Test Set, or equivalent. Using this arrangement, the operator can adjust the digital subsystem for BER alarm alignment and slicing. A typical connection arrangement is shown by the block diagram in Figure 2.6. In this arrangement, the Model 4647 IF Noise Test Set accepts the carrier signal from the modulators and adds calibrated white noise to the signal for output to the demodulator. The final result is the measurement of bit-error-rate versus Carrier/Noise or Error bits/Noise.

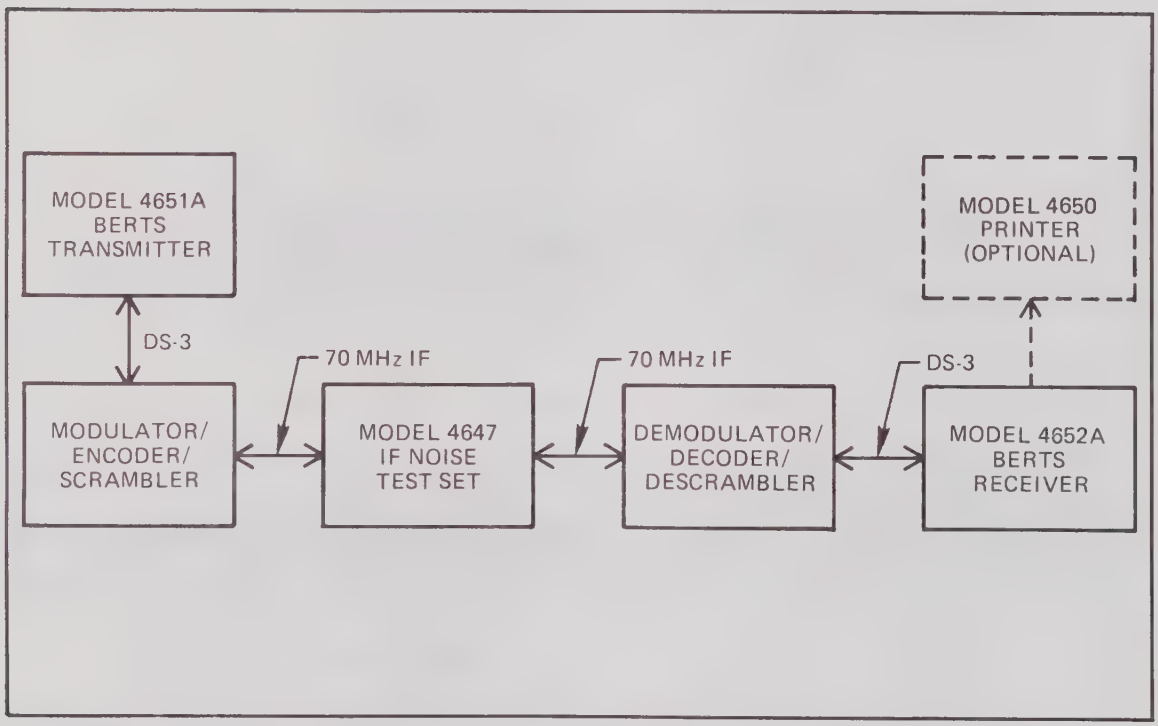


Figure 2.6 Typical Connections for BERTS Equipment When Testing Digital Modems with Added White Noise, Block Diagram

Table 3.1 - continued

Reference Symbol	Panel Label	Functional Description
8	(BIT ERROR RATE) CLEAR Switch	Provides for disabling internal error rate insertion circuitry. When enabled (depressed), the Error Rate Insertion circuit is disabled and the output data signal is provided with no bit or no parity errors.
9	(BIT ERROR RATE) 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8} Switches	Provides selection of which error rate will be inserted into the output data signal. These switches are only operational for data signals when the transmitter is operating in the PSEUDO RANDOM DATA (5) mode. The inserted errors will be evenly spaced BIT and PARITY errors.
10	(SINGLE ERROR) DATA BIT Switch	Pressing this switch inserts a single data bit error into the pseudo random data stream causing a single BIT and PARITY error.
11	(SINGLE ERROR) BIPOLAR VIOLATION Switch	Pressing this switch inserts a single bipolar violation into the pseudo random data stream. The error is generated by incorrectly performing the next three (3) zero substitution in a way to cause no bit and no polarity error but cause a bipolar violation for DS3 output.
12	DS3 OUTPUT Connector	A group of six 75-ohm impedance output data signal connectors that mate with a WECo Type 440 connector. The DS3 signal format and level is identical at each connector but each connector is individually buffered for load considerations.
13	POWER ON Switch	A two position switch controlling the application of operating source power to the transmitter circuits. A red panel indicator above the switch illuminates when source power, either ac or dc, is applied.
14	(OUTPUT) CLOCK Connector	This BNC-type OUTPUT connector provides a buffered output of the transmitter clock as selected by the (CLOCK) EXT (18) or (CLOCK) INT (17) switches. Output is 75 ohm ac coupled.

Table 3.1 - continued

Reference Symbol	Panel Label	Functional Description
15	(OUTPUT) DATA Connector	This 75-ohm BNC-type OUTPUT connector provides a data output signal in NRZ format including DS3 framing bits with no three (3) zero substitution. When used with the (OUTPUT) CLOCK (14) output signal, the DATA output signal can drive devices requiring NRZ, (unipolar) rather than B3ZS (bipolar) input signals. Output level can be selected for either TTL, ±1V, or 10K ECL by internal jumper.
16	(OUTPUT) M-SYNC Connector	This BNC-type OUTPUT connector provides a TTL level output pulse with 50-ohm or 75-ohm drive capability. The pulse rate is one pulse per superframe.
17	(CLOCK) INT Switch	Enabling (depressing) this switch selects the internal transmitter clock as the timing source for generation of the DS3 OUTPUT (12) signal.
18	(CLOCK) EXT Switch	Enabling (depressing) this switch selects the (CLOCK) INPUT (19) connector signal as the timing source for generation of the DS3 OUTPUT (12) signal.
19	(CLOCK) INPUT Connector	Pressing the (CLOCK) EXT (18) switch enables this connector to be a signal input for the transmitter circuits. This BNC-type connector is a 75-ohm impedance, ac coupled input requiring a 1.0 volt peak-to-peak clock signal in the frequency range of 10 MHz to 45 MHz.

3.3 REAR PANEL CONNECTORS

Figure 3.2 shows the rear panel of a Model 4651A BERTS Transmitter and the locations of ac power source connector and dc power source connector. Access to the ac power source connector fuse is illustrated in Chapter 2 - INSTALLATION, Figure 2.1.

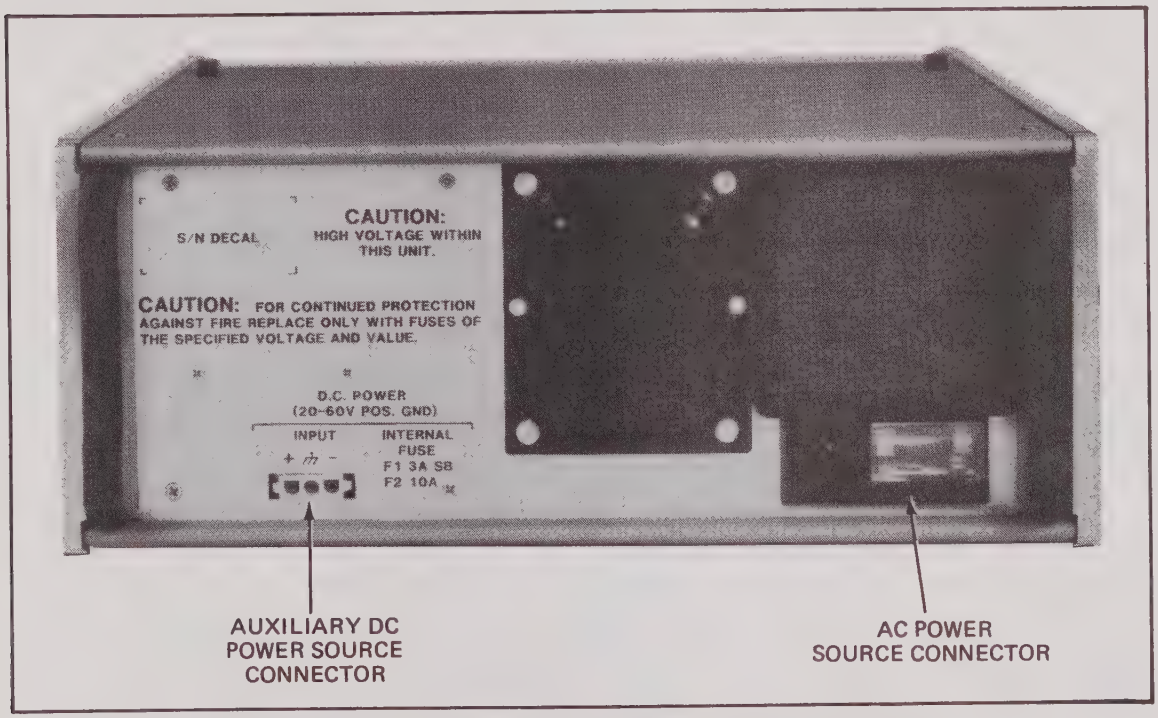


Figure 3.2. Model 4651A, Rear Panel Features

3.4 OPERATION

General. Although the operation of the Model 4651A BERTS Transmitter has been described in figures and tables, there are some operational modes of complex nature that require additional operating instructions. These instructions usually pertain to switches requiring a proper sequence to achieve a desired result or the interaction of various switch combinations.

The following descriptions will further identify switch and/or connector groups listed in the order below:

A. OUTPUT LEVEL Select
B. OUTPUT Signal Select
C. ERROR RATE Select
D. SINGLE ERROR Insert
E. OUTPUT Connectors
F. CLOCK Select

A. OUTPUT LEVEL SELECT

Pressing one of the three OUTPUT LEVEL switches controls the signal amplitude available at the six DS3 OUTPUT connectors. Pressing the LOW switch provides a DS3 OUTPUT signal level of 0.37 volt peak-to-peak. Similarly, pressing the HIGH switch provides a signal level of 1.82 volt peak-to-peak. When the DSX-3 switch is pressed, the HIGH output signal is preconditioned by a circuit network that simulates a signal path through 450 feet of 728A cable before being available at the DS3 OUTPUT connectors. Each DS3 OUTPUT connector is individually isolated with a 75-ohm driver.

B. OUTPUT SIGNAL SELECT

Selection of one or more OUTPUT switches determine the DS3 OUTPUT signal format. Switch combinations that provide reliable signal format are listed below. Unlisted switch combinations provide possible signal formats that are not reliable and are therefore undefined.

1. FRAMING Select

The FRAMING switch allows the selected data pattern (one of the four described below) to be transmitted with or without the DS3 framing structure. The button is alternate action, and selects framing when positioned "in". Note that no parity measurements can be made unless framing is selected.

2. PRBS Select

If the PRBS switch is pressed and remains in, the output data is a 32,767 bit pseudo random bit sequence. It should be noted that bit/parity errors can be inserted into the output signal only while the transmitter operates in this mode.

3. 1111 Select

If the 1111 switch is pressed and remains in, the output data is all ones.

4. 0000 Select

If the 0000 switch is pressed and remains in, the output data is all zeroes.

5. BLUE Signal Select

This function simulates an "idle channel" signal that is provided when both 1111 and 0000 switches are pressed and remain in. The output data is a repeated 1-0 sequence.

C. ERROR RATE SELECT

The ERROR RATE functions are provided when the transmitter is generating PSEUDO RANDOM DATA only. The functions are blocked when using any other mode of signal formatting. Error rates are provided from 10^{-3} to 10^{-8} in six switch selected steps. The errors are introduced in periodic locations as determined by dividing the 44.736 MHz clock but are not allowed to occur in framing bits. Using the 10^{-3} error rate for example, bit errors will be inserted at this rate but parity errors will occur at a lesser rate since there is only one parity bit per superframe of 4760 bits. The ERROR RATE - CLEAR switch is provided to disable the internal error rate insertion circuits.

D. SINGLE ERROR INSERT

The SINGLE ERROR function is provided when the transmitter is generating PSEUDO RANDOM DATA only. Pressing the SINGLE ERROR - DATA BIT switch inserts a single data bit error into the pseudo random data stream and therefore also causes a parity error to occur. Pressing the SINGLE ERROR - BIPOLAR VIOLATION switch inserts a single bipolar violation into the pseudo random data stream by incorrectly performing the next 3 zero substitution. The substitution is performed using the wrong polarity data one pulses. This causes no data bit errors but does cause a single bipolar violation.

E. OUTPUT CONNECTORS

Three BNC-type front panel outputs, each with 50-ohm drive capability, are provided. The M-SYNC connector provides one output pulse per superframe. Both CLOCK and DATA connectors provide NRZ outputs. The NRZ DATA signals contain framing bits and both DATA and CLOCK output signals can be directly connected in NRZ applications.

F. CLOCK SELECT

Two switches provide selection between internal (INT) and external (EXT) transmitter clock function. When the CLOCK-INT switch is pressed, the highly stable internal clock is connected to the transmitter circuitry and all operations use it as the reference. When the CLOCK-EXT switch is pressed, the front panel CLOCK-INPUT connector is enabled and signals applied to this connector are used by all the internal circuitry to generate appropriate output signals. The CLOCK-INPUT connector is ac coupled into 75-ohms impedance requiring a 1.0 volt peak-to-peak signal in the frequency range of 10 MHz to 45 MHz.

OPERATION NOTES

1. The operator should be aware that only one switch (CLOCK-INT OR CLOCK-EXT) at a time may be used for normal DS3 OUTPUT signals. These switches may be "tricked" into simultaneous in or out positions and output signals, if any, cannot be defined for this mode of operation.

2. The operator should be aware that if a signal is applied to the EXT-INPUT connector which is in excess of the 2.0 volt peak-to-peak specifications, or if the connecting cable and/or signal source is noisy, the excessive signal(s) may adversely affect the DS3 OUTPUT even when operating by CLOCK-INT mode.

G. NRZ DATA FORMAT

The three NRZ data signal formats available (i.e., TTL, ECL, and BIPOLAR) are selected by correctly positioning jumper connectors on the Output Amplifier printed circuit board (A3). See Figure 3.3.

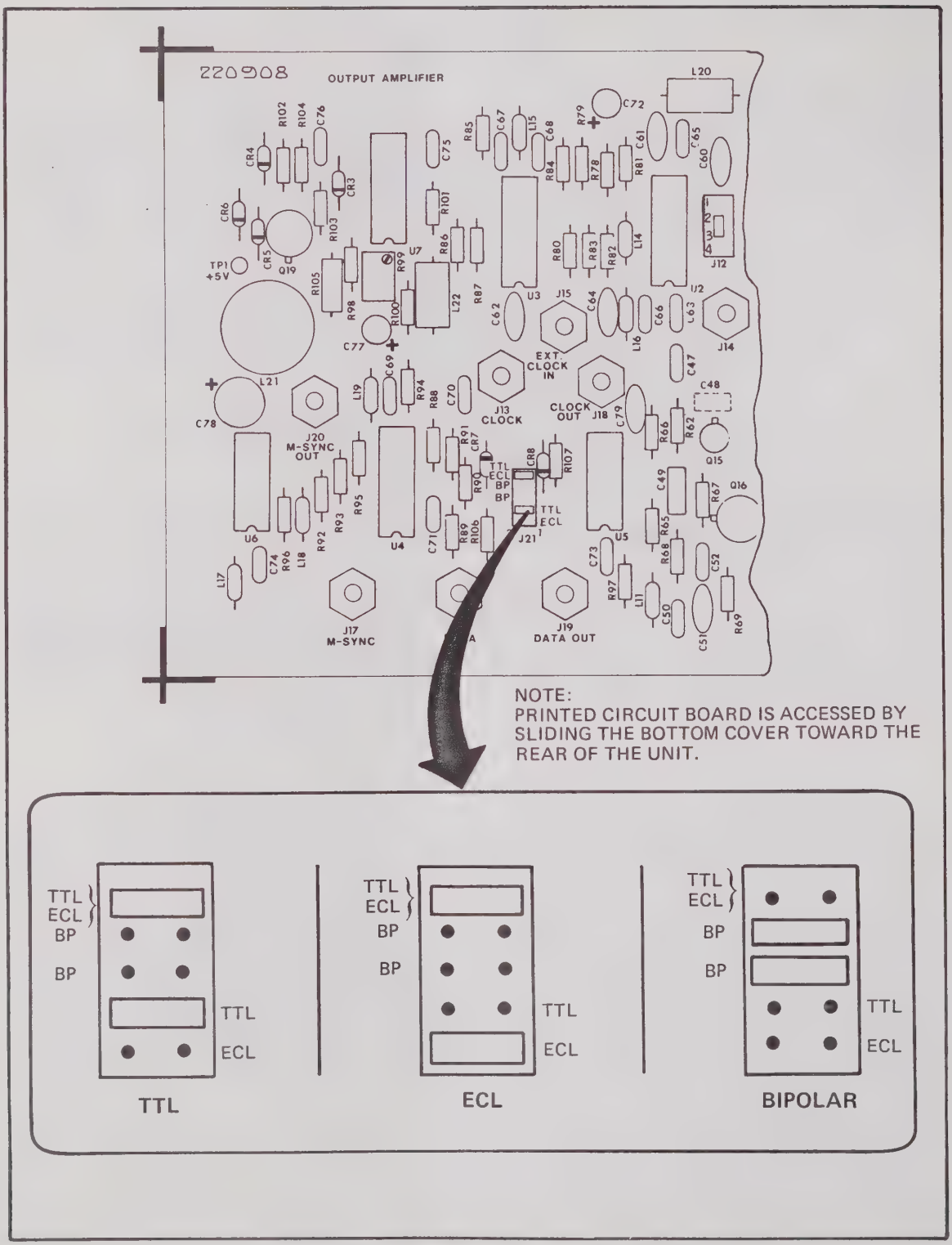


Figure 3.3. NRZ Data Format Select

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000\as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42		10^{-3}	30		10^3
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89	10^{-2}	10^{-4}	40	10^2	10^4
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38					
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88		10^{-5}	50		10^5
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39	10^{-3}	10^{-6}	60	10^3	10^6
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91		10^{-7}	70		10^7
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44	10^{-4}	10^{-8}	80	10^4	10^8
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99		10^{-9}	90		10^9
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55	10^{-5}	10^{-10}	100	10^5	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

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